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USE OF INDIVIDUAL INTERNODE DISTANCE AS A MEASURE OF SEASONAL GROWTH

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Abstract

Cotton plant monitoring is common practice in the US today. There are many components to plant monitoring depending on the management decision to be made. Grower management and environment both have influences on cotton plant performance. When conducting research trials, it is important to represent results in relation to the growing environment (both management and weather) experienced by the crop. Individual Internode Distance (IID) is the literal distance between successive nodes. It can be easily collected at the end of the season. Here we present general average values for different regions of the US cotton belt and show some specific examples of how IID documents either environmental differences or treatments differences in plant response.

Introduction

Cotton is an indeterminate perennial we grow as an annual. For a time during the year it produces both vegetative and reproductive growth. Many factors affect the balance between these two competing sinks. Plant monitoring and mapping during the past 30 years has developed tools that document the impact of specific management on crop response. The influence of pest management, plant density, row spacing, growth regulators, fertility, water management, diseases, temperature extremes, and plant variety on fruit retention and other plant parameters has been studied and documented.

Bourland et al. (1997) has demonstrated the value of data collection during the season to optimize management. Height-to-node ratio was demonstrated to be a good indicator of vegetative growth (Kerby et al., 1997). Seasonal growth rate was measured as change in height per change in node number. Growth rate near the time of flowering was related to field response to Mepiquat Chloride (MC) application (Kerby unpublished data from 12 field trials 1989 to 1992 in California). In the SJV of California, no response was noted when growth rate was less than 2.7 inches per node at this time.

Concepts for nodes above white flower (NAWF) were initially conceptualized by Waddle (1974) but unfortunately not further developed until later by groups in Arkansas and California. Nodes-above-cracked-boll (NACB) was developed as a late season measure of field maturity to aid in defoliation timing (Kerby et al., 1992). These are only a few of the examples of monitoring tools and techniques that have benefited crop management.

Delta and Pine Land Company (D&PL) conducts many on farm field trials each year. We understand from monitoring concepts and history that environment and management can have a large effect on the relative performance of one variety over another one. It would be potentially useful to document what stress factors were present at different times during the season as an aid to properly interpreting variety performance results. We introduce two additional terms to the cotton monitoring vernacular. Maximum internode distance (MID) is used as an in season measure of current growth rate. We tagged individual plants and measured the internode distance of each node, then re-measured these same plants at a later date to determine the number of nodes below the terminal nodes where elongation ceases. Our data suggested the internode four nodes below (between the 4^{th} and 5^{th} node) were nearly fully elongated, but is the most recent internode fully elongated (Kerby 1992 unpublished Australian data). MID has been used in management decisions, especially the need for Mepiquat chloride (MC). Individual internode distanced (IID) is a measure of internode distance for each node taken at the end of the season. The value should be indicative of vegetative growth factors present throughout the season. Additionally, the IID for an internode represents the growth rate present during the season when the field was at a growth stage represented by that internode number plus four more nodes.

This manuscript will provide averages and general ranges in IID for different cotton growing areas of the US cotton belt. A few examples of how it can be used to document the effects of environment and management on cotton plant vegetative development will be presented.

Materials and Methods

D&PL began collecting IID data several years ago. During the past two years we have collected end-of-season IID data on the standard variety in our most of our on farm variety trials. Some of the individuals who conduct University Official Variety Trials (OVT) have also collected IID on a reference variety, and they have supplied this data to us for use.

We select representative plants from the plot area, cut these plants below the cotyledons, and record the height of each node. For convenience, we sometimes use clippers and cut all branches so that the plant lies flat on a bench or pickup truck bed. A tape rule or measuring stick is placed at the cotyledons, and heights of each successive node are recorded either on paper or in an Excel micro developed to summarize the data. To reduce error in measures, cumulative height is measured. If the height of each internode were specifically measured from the first to last internode, there would be error associated with the measure of each node. This error would accumulate and result in a less accurate total measure of height accumulation. The Excel micro was written in a way to convert cumulative measures into individual internode distance for each node beginning with the distance from the cotyledons to the first node measured as 1. The program can handle up to 20 plants in an individual sample.

Not all plants in a sample produce the same number of nodes. The program is written to sum the change in height between nodes and divide it by the number of observations in the sample. For those plants not having as many nodes, upper internode values actually average in zero for those plants lacking a node. To do otherwise (calculate only the average internode distance for the biggest plants in the sample) would be to over estimate the contribution of the upper nodes to height accumulation.

Results

There were a total of 74 locations in 2001 and 2002 where IID data was collected for stripper cottons representing the areas of NM, the High Plains of TX, portions of OK, and all of KS. Figure 1 represents the average IID by node for this region. Some of these fields were irrigated, and others represent dry land conditions. The average IID of all fields did not exceed 2.0 and demonstrates the stressful environment typically present in this area. For the tallest 25% of fields, maximum IID was only 2.5 and occurred about node 11 which was near the time of first flower (IID of 11 + 4 nodes = 15 node stage of growth) IID's were similar for short and tall fields until IID 4 which would represent the 8 node stage of growth. Water supply is likely a key factor causing separation in field growth rates. Even many irrigated fields in this area are "supplemental" irrigation only and do not meet the full plant requirement.

There were a total of 547 locations in 2001 and 2002 where IID data was collected for picker cottons from TX to VA. NM, AZ, and CA are not represented in these groups. Figure 2 represents the average IID by node for this broad region. This vast region is made up of a wide variety of growing conditions, with water availability being a significant variable between fields. The average IID of all fields reached a maximal value just below 2.4 at the IID 10 or 11. This is also near the time of first flower (IID node 11 + 4 = node growth stage of approximately 15). The tallest 25 % of fields reached an average IID of 2.8 at IID 12 (16^{th} node stage of growth). Water supply is a significant, but not the only variable in field to field average IID. Variety, fertility, growth regulation, disease, and fruit set likely all contribute to significant differences in picker cotton IID.

Figure 3 provides an average IID comparison for stripper cottons, picker cottons (TX and East), the tallest 25 % of picker cotton fields, and calculated IID for the San Joaquin Valley (SJV) of CA from growth data of Kerby et al. (1997). Differences between stripper and picker cottons from TX to VA have already been described. The SJV has a clear and distinctly different growth pattern that is even different from the tallest 25 % of the picker cotton fields from TX to VA. The SJV has 100 % irrigation, summers with limited cloud cover, optimum temperatures for growth, and varieties grown that are vegetative and indeterminate. These SJV IID values were representative of Acala SJ-2 with management from the late 1980's. Current varieties and management may have IID's that are some what lower than these values. However, the SJV due to environment, full irrigation without the treat of summer rain, and with consistently high boll retention, early season IID that approaches 3.0 is typical and results in high yields because ultimately a boll load decreases IID. The decline from IID node 16 is abrupt and steep indicating plants have a heavy boll load and they move into a strong cutout.

Figure 4 compares IID of a dry land and an irrigated field in GA to the IID of the SJV of CA. All fields had comparable IID through about IID node 8. At this point both GA fields had IID lower than the SJV. The dry land field IID steadily declined indicating drought persisted with little if any plant growth recovery. The irrigated GA field had a decline in IID from node 8 to 11 (plant node stage 12-15), then began recovery and equaling the SJV IID values in the latter portion of the season. The growth pattern strongly suggests the first irrigation was delayed approximately 3 nodes more than what would have likely produced an IID similar to the SJV.

Figure 5 demonstrates the capacity of IID to display the difference in growth habit of varieties. Both varieties were grown in the same field each receiving the same management. SG 215 BG/RR is known for strong early season vigor and is considered an early season variety. DP 555 BG/RR is a full season variety with average early season vigor. DP 555 BG/RR IID response to growth regulators is illustrated in Figure 6. DP 555 BG/RR is a variety with strong potential for growth during the flowering period, especially on fertile soils with sufficient water. This test plot had good fertility, and in several instances rains followed irrigations promoting strong vegetative growth.

Many more examples of the utility of IID to document how varieties differentially respond to environments, or how a variety responds to differential treatments could be provided. However, the illustrations presented here serve to demonstrate the utility of IID to provide a visual summary of how the cotton plant responded to the growing conditions throughout the season. It has become a standard practice to collect this data for reference varieties in D&PL large scale on farm trials.

References

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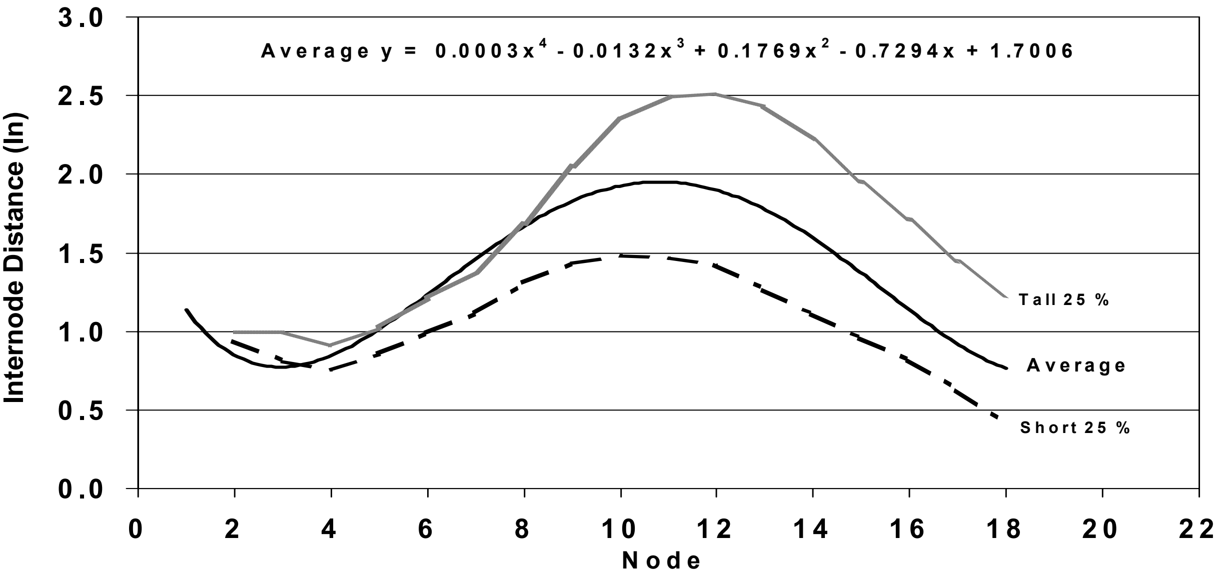

Figure 1. Individual Internode Distance (IID) for 74 stripper cotton trials (2001 to 2002) with average final height of 24.2 inches and 17.8 nodes as well as IID for the tall and short 25 % of fields.

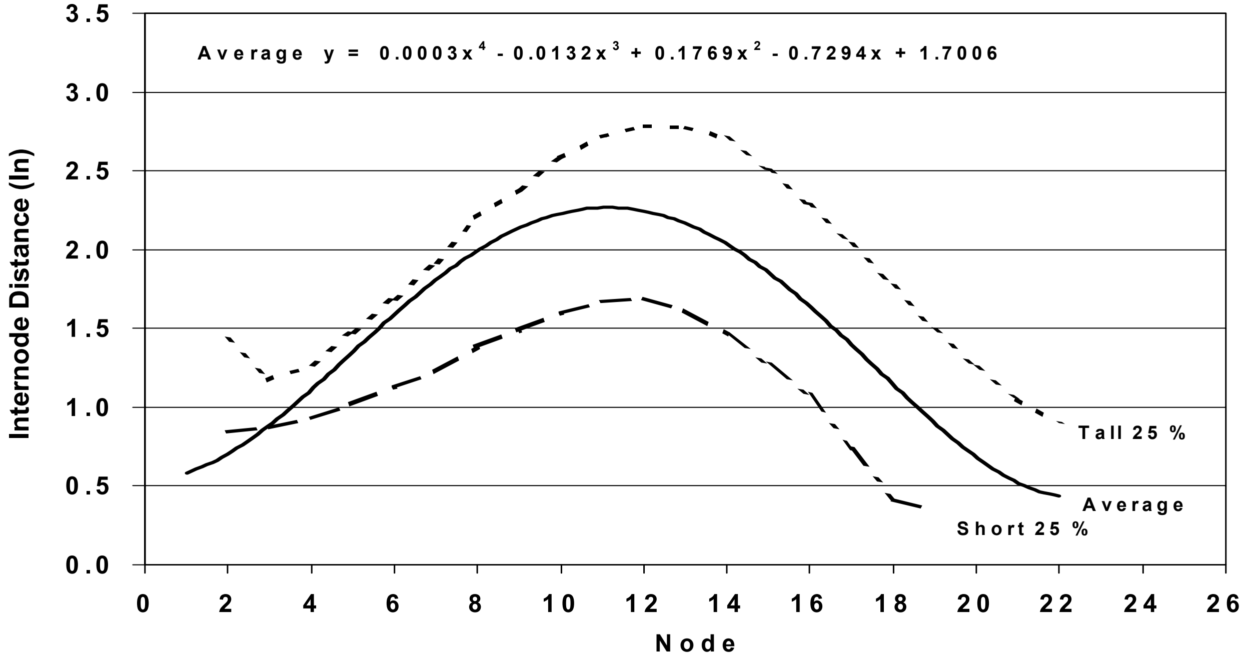

Figure 2. Individual Internode Distance (IID) for 547 picker cotton trials (2001 to 2002) with average final height of 31.9 inches and 19.3 nodes as well as IID for the tall and short 25 % of fields.

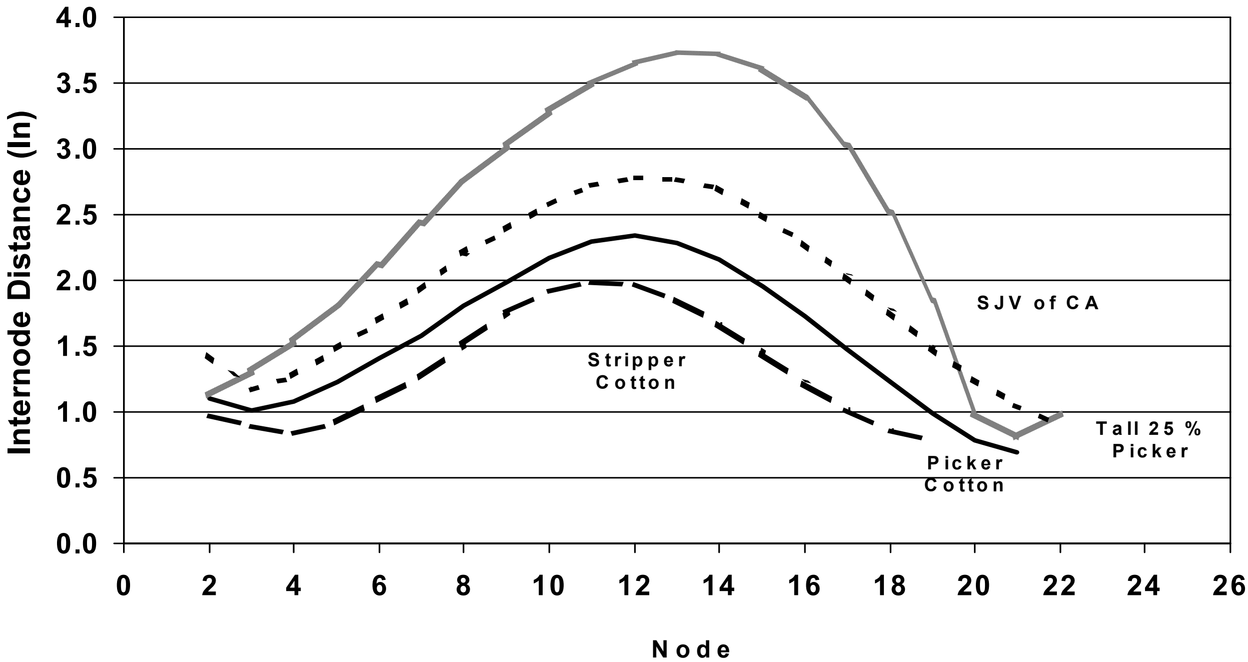

Figure 3. Individual Internode Distance (IID) for 547 picker cotton trials (2001 to 2002) with average final height of 31.9 inches and 19.3 nodes as well as IID for the tall and short 25 % of fields.

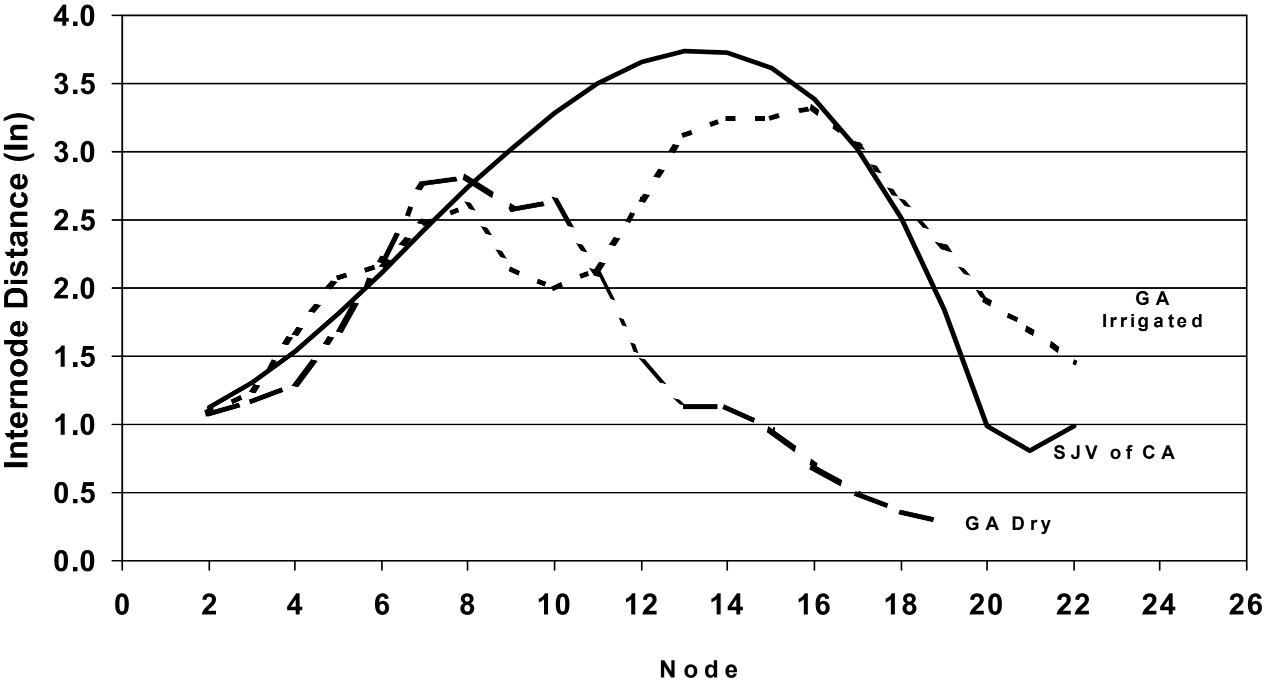

Figure 4. Individual Internode Distance (IID) calculated values in the San Joaquin Valley of California compared to dry land (ID # 2060000126) and irrigated cotton (ID # 2049000078) in Georgia in 2001.

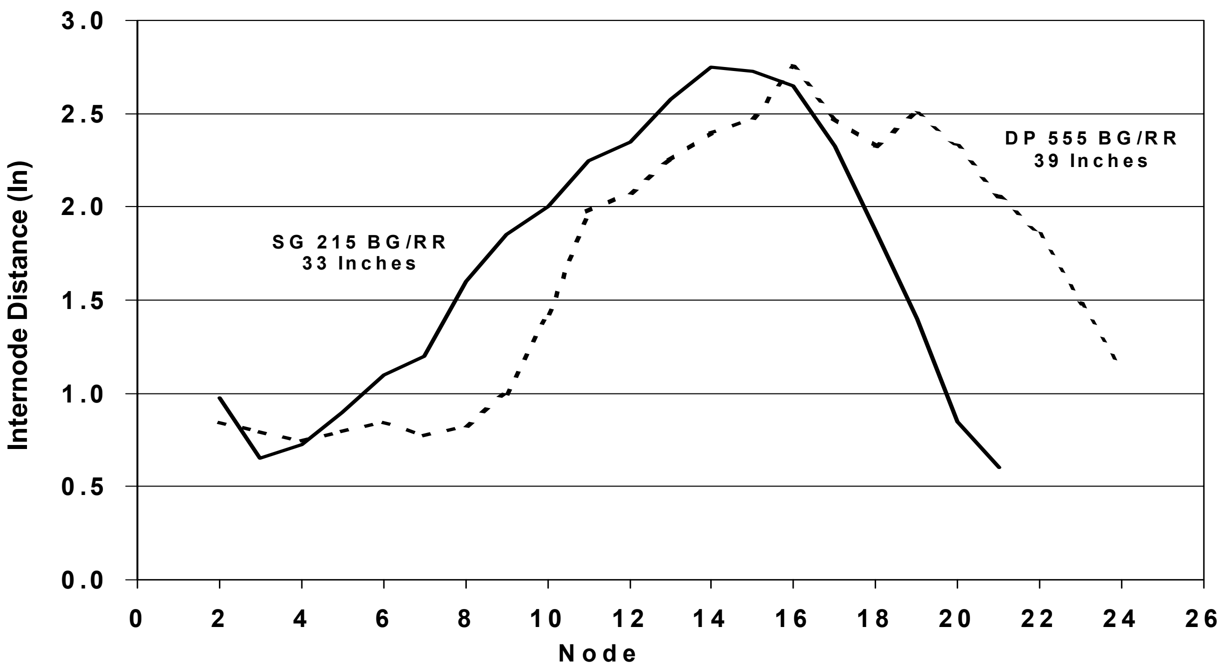

Figure 5. SG 215 BG/RR and DP 555 BG/RR IID through the season grown side by side in the same field in 2002. Texas AST # A02W3CPE22K06.

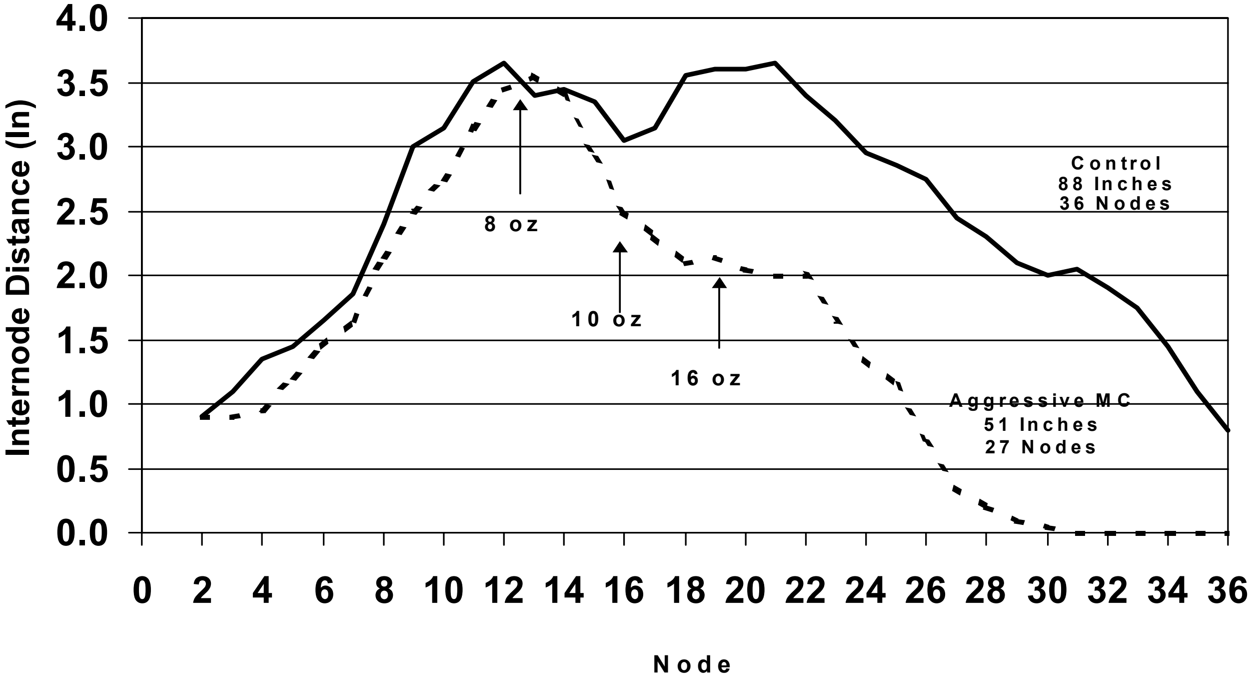

Figure 6. Response of DP 555 BG/RR IID to aggressive growth regulator control. Winterville, MS 2002.